

US-PAT-NO: 4594665

DOCUMENT-IDENTIFIER: US 4594665 A

TITLE: Well production control system

----- KWIC -----

**US Patent No. - PN (1):
4594665**

Detailed Description Text - DETX (4):

The load cell 47 provides a DC output signal which is proportional to the load on the sucker-rod string 16, and an analog-to-digital converter 48 provides a corresponding digital signal to a computer 49a. A position measuring means or transducer 53 measures the vertical position of the sucker-rod string 16 by providing a voltage which is proportional to the angle of the walking beam 22 and thus is proportional to the position of the rod string 16. The digital-to-analog converter 48 also converts the signal from the transducer 53 into a digital signal which is used by the computer 49a and by an XY plotter 54. Signals are transferred between the computer 49a and a computer 49b by a pair of wires 55a, 55b. Instructions from a

keyb ard 60 and
from a on trol and display unit 61 and output signals from the
load ell 47 ar
used by the XY plotter to provide a visual plot of the
characteristics of the
particular well which the rod string operates. The plotter 54 can
be used for
observing operation of the well and for setting up the equipment
to monitor the
well. After setup is completed the plotter can be disconnected,
or if desired
the plotter can be eliminated altogether and the display unit 61
or other means
for setting up the equipment can be used.

Detailed Description Text - DETX (18):

The portion of the computer system disclosed in FIG. 6A
comprises a motor
controller 71 for receiving signals from the load cell 47 and from
transducer
53 and for using these signals to determine the sequence for
controlling the
motor 30. The computer 49b disclosed in FIG. 6B comprises a
display programmer
72 for using the load cell and transducer signals transmitted from
computer 49a
to operate the XY plotter 54. Signals are interchanged between
the motor
controller 71 and the display programmer 72 over the pair of
interconnecting
wires 55a, 55b.

Detailed Description Text - DETX (20):

Clock pulses for driving the micr c ntr llers are stabilized by a

**pair of
crystals 81a, 81b. The controller 73a is connected to a power
reset circuit 82
to warn that power to the controller is failing. An indicating
device 83a
receives visual display information from an input/output interface
84 and the
graphic display 61 receives visual display information from a
display
controller 85. Programs for operating the motor controller 71 and
the plotter
programmer 72 are stored in the PROMS 74a, 74b and data for
use in the system
is stored in the RAMS 75a, 75b. A load/stroke conditioner 88
(FIG. 6A)
amplifies and filters signals transmitted from the load cell 47 and
the
transducer 53 and sends the smoothed signals to the bus 80a
through a
multiplexer 89 and the analog-to-digital converter 48. A buffer 87
(FIGS. 1,
6A) provides signals to operate the XY plotter 54 in response to
signals from
the multiplexer 89. An analog-to-digital converter which can be
used is the
model AD574A manufactured by Analog Devices.**

US-PAT-NO: 5406482

DOCUMENT-IDENTIFIER: US 5406482 A

**TITLE: Method and apparatus for measuring pumping
rod position
and other aspects of a pumping system by use of an
accelerometer**

----- KWIC -----

10/7/04, 683

**US Patent No. - PN (1):
5406482**

10/24/04
Tues 2:PM
7:3

Brief Summary Text - BSTX (12):

In a still further aspect of the present invention, the output from an accelerometer mounted on a pumping system is displayed on the screen of a computer to indicate operation of the pumping system, including any anomalies in the operation such as unusual vibrations or pounding.

Drawing Description Text - DRTX (9):

FIG. 7A is an accelerometer output waveform produced on a screen display showing normal operation of a pumping system and FIG. 7B is an accelerometer output waveform displayed on a screen which indicates abnormal vibrations and

therefore abnormal operation of a pumping system, and

Detailed Description Text - DETX (20):

The waveforms shown in FIGS. 4A-4D, 5A and 5B are displayed on the display screen 52 of the computer 50, shown in FIG. 1. This allows the operator to see the signals which have been collected, and those which have been processed.

Detailed Description Text - DETX (21):

In a prior technique, the load on a polished rod was acquired and displayed as a function of the polished rod position. This used mechanical test equipment in which the display of polished rod load versus polished rod position was produced by rotating a drum on which the load was scribed. To produce a display, such as shown in FIG. 5A, the load on the rod and the position of the rod must both be known.

Detailed Description Text - DETX (27):

A still further aspect of the present invention is the utilization of an accelerometer for the observation of pumping system performance as illustrated in FIGS. 7A and 7B. FIG. 7A represents the output signal from the accelerometer 40 for a pumping system, such as shown in FIG. 1, in which the operation is normal. This is indicated by the generally smooth acceleration

curve. FIG. 7B is the output signal from the accelerometer 40 for the same or similar pumping unit, but with improper operation. The signal in FIG. 7B includes abnormal vibrations indicated by the lines 102, 104 and 106. These abnormal vibrations are essentially repeated in each of the cycles of the signal. Such vibrations can be generated by defective gear teeth, worn bearings, abnormal surface conditions, unit misalignment, abnormal downhole pump conditions, and downhole mechanical problems. These large acceleration spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently on the screen 52 of the computer 50 so the abnormalities can be readily determined. The signal in FIG. 7A can be recorded at a time when it is known that the pumping system is working well or it can be a representative signal for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (9):

3. A method for measuring the position of a rod as recited in claim 1 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal or said third signal.

Claims Text - CLTX (17):

7. A method for measuring the position of a rod as recited in claim 4 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.

Claims Text - CLTX (28):

11. A method for measuring the position of a rod as recited in claim 8 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.

US-PAT-N : 5464058

DOCUMENT-IDENTIFIER: US 5464058 A

TITLE: Method of using a polished rod transducer

----- KWIC -----

Brief Summary Text - BSTX (16):

Still a further object of the present invention is the utilization of computers and computer software to process and display the data generated by the novel polished rod transducer. Such useful display screens include displays of the raw change in polished rod load data, surface cards (polished rod load versus cycle position), surface cards showing absolute polished rod load, downhole cards showing change in pump load versus cycle position, and downhole cards showing absolute pump loading.

Detailed Description Text - DETX (66):

FIG. 19 shows a surface dynamometer card obtained from transducer 60 data.

The transducer 60 acquired surface data was used to calculate the downhole card shown in FIG. 20. The minimum load value was set to zero. The same offset used on the downhole card was used on the surface data to display a surface

card. Note that an operator can visually analyze that the downhole pump is less than one-half full of liquid.

Detailed Description Text - DETX (69):

Following display operation block 304, operation is transferred to block 306 to generate a surface card of uncalibrated rod load versus rod position (see FIG. 15). Next, in block 308 the uncalibrated surface card is displayed on the computer screen.

Detailed Description Text - DETX (70):

After display in block 308 operation is transferred to block 310 to generate from the surface card a downhole card which shows uncalibrated pump load versus pump position (see FIG. 17). This is determined as set forth in the article by Gibbs noted above. This uncalibrated downhole card is then displayed on the computer screen as set forth in block 320.

Detailed Description Text - DETX (72):

In step 323 the calibrated downhole card is shown on the computer display screen.

Claims Text - CLTX (26):

14. A method for determining absolute load on a polished rod as recited in

**claim 12 including the step of displaying said absolute value
surface card on a
display screen.**

US-PAT-NO: 5589633

DOCUMENT-IDENTIFIER: US 5589633 A

****See image for Certificate of Correction****

**TITLE: Method and apparatus for measuring pumping
rod position
and other aspects of a pumping system by use of an
accelerometer**

----- KWIC -----

**US Patent No. - PN (1):
5589633**

Brief Summary Text - BSTX (12):

**In a still further aspect of the present invention, the output
from an
accelerometer mounted on a pumping system is displayed on the
screen of a
computer to indicate operation of the pumping system, including
any anomalies
in the operation such as unusual vibrations or pounding.**

Drawing Description Text - DRTX (9):

**FIG. 7A is an accelerometer output waveform produced on a
screen display
showing normal operation of a pumping system and FIG. 7B is an
accelerometer
output waveform displayed on a screen which indicates abnormal**

**vibrations and
the normal operation of a pumping system, and**

Detailed Description Text - DETX (20):

The waveforms shown in FIGS. 4A-4D, 5A and 5B are displayed on the display screen 52 of the computer 50, shown in FIG. 1. This allows the operator to see the signals which have been collected, and those which have been processed.

Detailed Description Text - DETX (21):

In a prior technique, the load on a polished rod was acquired and displayed as a function of the polished rod position. This used mechanical test equipment in which the display of polished rod load versus polished rod position was produced by rotating a drum on which the load was scribed. To produce a display, such as shown in FIG. 5A, the load on the rod and the position of the rod must both be known.

Detailed Description Text - DETX (27):

A still further aspect of the present invention is the utilization of an accelerometer for the observation of pumping system performance as illustrated in FIGS. 7A and 7B. FIG. 7A represents the output signal from the accelerometer 40 for a pumping system, such as shown in FIG. 1, in which the operation is normal. This is indicated by the generally smooth

acceleration

urve. FIG. 7B is the output signal from the accelerometer 40 for the same

similar pumping unit, but with improper operation. The signal in FIG. 7B

includes abnormal vibrations indicated by the lines 102, 104 and 106. These

abnormal vibrations are essentially repeated in each of the cycles of the

signal. Such vibrations can be generated by defective gear teeth, worn

bearings, abnormal surface conditions, unit misalignment, abnormal downhole

pump conditions, and downhole mechanical problems. These large acceleration

spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe

shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently

on the screen 52 of the computer 50 so the abnormalities can be readily

determined. The signal in FIG. 7A can be recorded at a time when it is known

that the pumping system is working well or it can be a representative signal

for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (5):

displaying said first digital data set as a waveform on a display screen of

said computer wherein said waveform includes features indicating performance of

said pumping system.

Claims Text - CLTX (8):

displaying at least one marker on said screen in conjunction with said waveform to indicate a position of said rod.

Claims Text - CLTX (9):

3. A method for analyzing the performance of a pumping system as recited in claim 1 including concurrently displaying on said screen a second waveform representing the output signal for said accelerometer for normal operation of said pumping system.

US-PAT-NO: 5406482

DOCUMENT-IDENTIFIER: US 5406482 A

**TITLE: Method and apparatus for measuring pumping
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curve. FIG. 7B is the output signal from the accelerometer 40 for the same or similar pumping unit, but with improper operation. The signal in FIG. 7B includes abnormal vibrations indicated by the lines 102, 104 and 106. These abnormal vibrations are essentially repeated in each of the cycles of the signal. Such vibrations can be generated by defective gear teeth, worn bearings, abnormal surface conditions, unit misalignment, abnormal downhole pump conditions, and downhole mechanical problems. These large acceleration spikes (lines 102, 104 and 106) in the acceleration signal indicate that severe shock loads occur at these times. FIGS. 7A and 7B are displayed concurrently on the screen 52 of the computer 50 so the abnormalities can be readily determined. The signal in FIG. 7A can be recorded at a time when it is known that the pumping system is working well or it can be a representative signal for a pumping unit of the particular type which is to be examined.

Claims Text - CLTX (9):

3. A method for measuring the position of a rod as recited in claim 1 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal or said third signal.

Claims Text - CLTX (17):

7. A method for measuring the position of a rod as recited in claim 4 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.

Claims Text - CLTX (28):

11. A method for measuring the position of a rod as recited in claim 8 further including the step of displaying on a computer screen one or more waveforms corresponding to either said first signal, said second signal, or said third signal.